I. C. 6354

SEPTEMBER, 1930

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INFORMATION CIRCULAR

FATALITIES IN ALABAMA COAL MINES

BY

F. E. CASH AND H. B. HUMPHREY

I.C. 6354
September 1930.

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By F. E. Cash[2] and H. B. Humphrey[3]

INTRODUCTION

The Birmingham coal-mining district of Alabama has many local physical conditions that contribute largely to the problem of preventing coal-mine fatalities. Coal mines of Alabama have been under the supervision of the State mine inspector since 1892, and reports have been made with increasing completeness since that time. The U. S. Bureau of Mines has maintained a station of the safety division in the district since 1912 to cooperate with operators and the State in the advancement of safety in mining.

A description of conditions in regard to fatal accidents as they have been and as they now are in Alabama, compared with the entire United States, will indicate the progress that has been made and that should still be made in reducing fatal mine accidents.

ACKNOWLEDGMENTS

Acknowledgments are made of aid by Chief Inspector W. B. Hillhouse and Secretary H. J. Mead, of Alabama, who made available the reports of their office for the preparation of this paper.

The other sources of information used are here listed:

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the followi footnote acknowledgment is used: "Reprinted from U.S. Bureau of Mines Information Circular 6354."

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PART I -- FATALITY RATES

In Table 1 are given the fatality rates for Alabama and for the United States by years from 1900 to 1929, inclusive, as obtained from publications of the U. S. Bureau of Mines and annual reports of the State mine inspector. The usual ratings based on tonnage production, which are purely cost figures, are given, as well as the more significant basis of time exposure, which measures the degree of safety to the worker.

The high fluctuations in the Alabama ratings arise from major disasters occurring in those years. In 1905 one explosion resulted in 108 fatalities; in 1907, 56 lives were lost in an explosion; in 1910, three major explosions caused a loss of 128 lives; and in 1911, 128 lives were lost in one explosion. For clearer comparison there are given, at the end of the table for periods shown, true averages calculated from the total tonnages or hours and fatal accidents in each period.

TABLE 1. - Comparison of fatality rates

For Alabama and the United States

Year	Deaths per million tons produced		Deaths per million man-hours worked	
	U. S.	Ala.	U. S.	Ala.
1900	5.70	4.45	1.91	1.16
1901	5.37	4.57	1.80	1.05
1902	6.31	4.83	2.06	1.28
1903	5.00	4.88	1.75	1.23
1904	5.81	7.45	1.94	2.32
1905	5.73	15.65	2.01	4.46
1906	5.20	7.45	1.88	2.07
1907	6.80	10.70	2.65	3.11
1908	6.00	9.37	2.00	2.65
1909	5.75	9.35	2.20	2.80
1910	5.62	14.77	2.15	4.43
1911	5.35	13.97	2.02	4.40
1912	4.53	7.35	1.84	2.27
1913	4.8[illegible]	6.95	2.07	2.05
1914	4.78	8.15	1.78	2.40
1915	4.27	4.15	1.69	1.29
1916	3.77	6.50	1.53	1.83
1917	4.14	5.30	1.75	1.45
1918	3.83	5.65	1.61	1.86
1919	4.18	5.85	1.77	1.83
1920	3.47	4.50	1.57	1.41
1921	3.94	6.15	1.74	2.29
1922	4.15	9.75	2.02	3.50
1923	3.74	4.26	1.82	1.47
1924	4.22	3.93	1.99	1.42
1925	3.84	7.95	1.93	2.73
1926	3.85	6.45	1.86	2.17
1927	3.72	4.60	1.82	1.65
1928	3.78	3.70	1.92	1.33
1929	3.60	3.91	1.78	1.40
Average 30 years	4.56	6.95	1.86	2.15
Average				
1900- 1909	5.77	8.20	2.03	2.27
1910- 1919	4.50	7.70	1.75	2.30
1920- 1929	3.82	5.52	1.83	1.93
1925- 1929	3.76	5.41	1.85	1.89

For the 30-year period the average fatality rate in Alabama is higher than for the United States under both ratings. The reason for the higher average rate is shown by the yearly changes and by the 10-year summaries. In the period from 1900 to 1909 an average of 8.20 men was killed for each million tons produced, compared with 5.77 for the United States, and 2.27 for each million hours worked compared with 2.03 for the United States. In 1910 to 1919 inclusive, the ratings were 7.70 per million tons produced and 2.30 per million hours worked for Alabama and 4.50 and 1.75 for the United States, showing that while there was a fair improvement in the country as a whole, conditions in Alabama were practically unchanged. From 1920 to 1929 the averages are: Alabama, 5.52 per million tons produced and 1.93 per million hours worked; United States, 3.82 and 1.83. For the last five years, 1925 to 1929, inclusive, the averages are slightly more in favor of Alabama, which has ratings of 5.41 per million tons produced and 1.89 per million hours worked, compared with 3.76 and 1.85 for the United States. The improvement in both ratings for Alabama is marked, and in the last three years the industry in Alabama has become relatively safer than in the country as a whole. The slight advantage of the rest of the country on a tonnage basis is due to the greater average tonnage produced per man-hour than in the State, as is shown in Table 2. These figures were obtained from the same sources as Table 1. It will be noted that when production is suddenly increased, as in 1910, 1916, and 1922, the accident rate rises correspondingly; the death rates per million tons changed in 1910 from 9.35 to 14.77; in 1916, from 4.15 to 6.50; and in 1922, from 6.15 to 9.75. The death rates per million hours worked increased in 1910 from 2.80 to 4.43, in 1916 from 1.29 to 1.83, and in 1922 from 2.29 to 3.50. This increase in severity and frequency is caused by increasing tonnage without giving corresponding regard to care in the work and to the safeguards usually employed. Similarly, when production is greatly reduced at any time the accident rate rises, probably due to the mistaken idea that omission of safeguards and reduced standards and supervision are an economy. Such reductions occurred in 1914, 1919, and 1921, with increases in the fatal accidents.

The figures in Table 1 are repeated in the accompanying graph (fig. 1) to show the relation of Alabama rates to those of the United States and the present improvement over the extremely great hazards of the past.

Although only a different form of the tonnage rating, the number of tons mined per fatality is a common standard of measurement in considering the fatal accident record in coal mining and it is by no means a fair method. The 30-year average for the coal mines of the United States is 220,000 tons mined per fatality, while in Alabama for that period it is 144,000 tons. The highest average for the United States was in 1920--290,000 tons per fatality; the highest for Alabama was in 1928--269,494 tons, as compared with an average of 278,000 tons per fatality for the United States for that year. The lowest average for the United States was 144,000 tons in 1907, and for Alabama 64,325 tons per man killed in 1905.

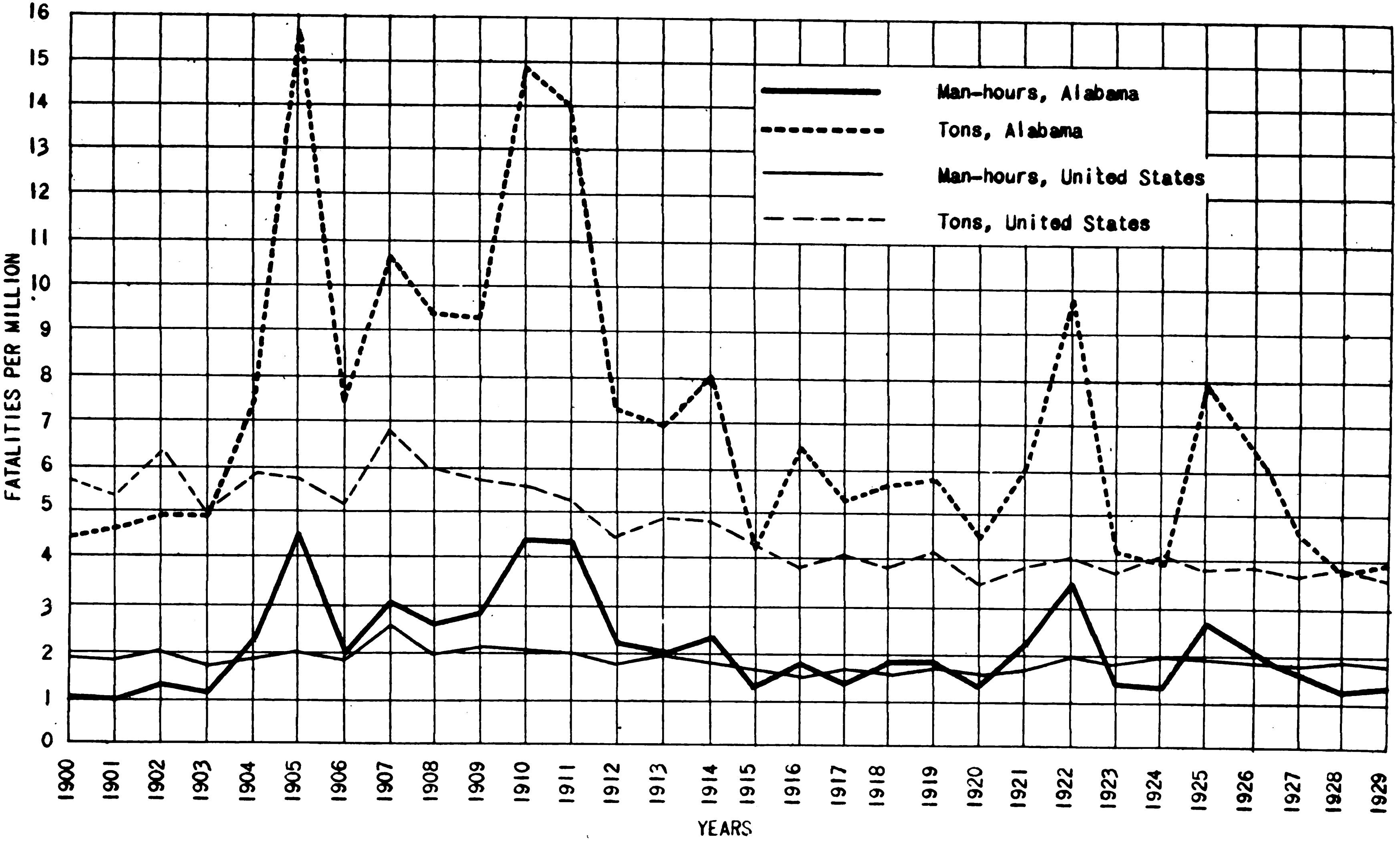

Figure 1.- Fatality frequency and severity rates for Alabama and for the United States

TABLE 3.-

Production and labor in Alabama and the United States

Year	Tonnage		Man-hours		Tons per man-hour	
	U. S.	Ala.	U. S.	Ala.	U.S.	Ala.
1900	265,000,000	8,273,362	778,500,000	32,000,000	0.39	0.26
1901	290,000,000	8,970,617	865,500,000	39,000,000	.34	.23
1902	300,000,000	10,329,479	918,400,000	39,000,000	.33	.27
1903	350,000,000	11,700,753	1,002,000,000	46,227,684	.35	.26
1904	345,000,000	11,273,151	1,032,000,000	36,251,712	.34	.31
1905	390,000,000	11,900,153	1,108,000,000	41,977,125	.35	.28
1906	410,000,000	12,851,775	1,135,000,000	46,252,209	.36	.28
1907	475,000,000	14,424,863	1,215,000,000	49,474,480	.39	.29
1908	410,000,000	11,523,299	1,222,000,000	40,745,214	.33	.28
1909	460,800,000	13,790,268	1,200,000,000	46,000,000	.38	.30
1910	501,596,378	16,139,228	1,305,000,000	53,935,890	.38	.30
1911	496,371,126	15,011,853	1,311,000,000	47,693,835	.38	.31
1912	534,466,580	16,513,040	1,311,000,000	53,193,665	.41	.31
1913	570,048,125	17,907,284	1,346,000,000	60,876,915	.42	.29
1914	513,525,477	15,525,903	1,378,437,219	52,666,362	.40	.30
1915	531,619,487	15,266,831	1,339,278,688	49,073,157	.40	.31
1916	590,098,175	18,234,625	1,452,788,095	64,934,604	.41	.28
1917	651,402,374	20,413,811	1,575,863,591	74,434,542	.42	.28
1918	678,211,904	19,521,840	1,599,853,614	59,139,496	.42	.33
1919	553,952,259	15,928,196	1,309,154,891	51,000,000	.42	.31
1920	658,264,932	17,391,437	1,451,162,000	55,500,000	.45	.31
1921	506,395,401	13,015,017	1,145,738,345	34,919,100	.44	.37
1922	476,951,121	18,757,681	979,994,880	52,256,400	.48	.36
1923	657,903,671	20,919,303	1,356,088,890	60,409,800	.48	.35
1924	571,613,400	19,615,931	1,207,474,560	54,210,600	.48	.36
1925	581,869,890	20,408,656	1,160,333,952	59,064,800	.50	.34
1926	657,804,437	21,508,812	1,352,840,229	64,048,500	.48	.34
1927	597,859,000	20,190,926	1,219,079,373	56,499,000	.49	.36
1928	576,093,000	18,056,116	1,135,542,452	50,409,000	.51	.36
1929	608,992,000	18,416,000	1,225,000,000	51,683,000	.50	.36
Total 30 Years	15,191,038,000	473,776,000	37,139,000,000	1,523,000,000	0.41	0.31
1900-1909	3,696,000,000	115,038,000	10,477,000,000	417,000,000	0.35	0.28
1910-1919	5,621,291,000	170,458,000	14,429,000,000	567,000,000	.39	.30
1920-1929	5,873,746,525	188,279,879	12,233,255,000	539,000,000	.48	.35
1925-1929	3,002,618,000	98,580,510	6,092,796,000	281,704,300	.49	.35

Tabulated averages for different periods are given below in Table 3.

TABLE 3. - Tons mined per fatality

	Tonnage mined		Men killed		Tons per man killed	
	U. S.	Ala.	U. S.	Ala.	U. S.	Ala.
1900 1909	3,696,000,000	115,038,000	21,391	942	173,000	122,000
1910 1919	5,621,300,000	170,458,000	25,229	1310	223,000	130,000
1920 1929	5,873,746,575	188,279,879	22,448	1040	261,660	181,039
1925 1929	3,002,618,000	98,580,510	11,333	533	264,944	188,706
Year 1927	597,859,000	20,190,926	2,224	93	268,821	217,106
Year 1928	576,033,000	18,056,116	2,176	67	264,702	269,494
Year 1929	608,992,000	18,416,000	2,181	72	279,226	255,778
1900 1929	15,191,038,000	473,776,000	69,068	3292	220,000	144,000

As this table expresses the same relationship as the rate per million tons produced the same limitation applies to both, namely that they give only cost data, without showing the risk of the man engaged in the work.

In this period of 30 years there were recorded 69,068 fatal accidents in coal mines of the United States. During this period Alabama produced 3.1 per cent of all the coal in the United States, and 4.8 per cent of the men killed in coal mining worked in Alabama mines. In 1929 Alabama produced 3 per cent of the coal in the United States and 3.3 per cent of all coal-mine fatalities occurred in Alabama mines. The tonnage fatality rate is still higher than that of the country as a whole; however, rapid progress is being made toward safer operation, as indicated in the following records:

Certificates of honor were awarded by the Joseph A. Holmes Safety Association in March, 1930:

> "To the Western Division of the DeBardeleben Coal Corporation, Coal Valley, Alabama, for having worked an average force of 893, from February 3, 1928, to February 3, 1930, a total of 2,553,835 man-hours without a fatality or a permanent total disability and with but one permanent partial disability."

and

"To the New Castle No. 2 and No. 6 Mines, New Castle, Alabama, for having worked from November 1919 to January 1, 1930, or over 10 years, with but one fatality and with a coal tonnage of 3,170,358. During 1929 an average force of 335 was employed."

The record of the Powhatan mine in Jefferson County, Ala., is exceptionally good. From the start of operations in 1918 until January 12, 1929, 2,130,178 tons were produced without a fatal accident in a period of 11 years. Including 1929, the tonnage per fatality was 2,352,296 tons with 220 men employed in 1929.

Dora No. 33 mine of the DeBardeleben Coal Corporation of Hull, Ala., won the bronze trophy of the National Safety Competition for 1929, as first prize in this nation-wide competition, having produced in the calendar year 1929, 144,885 tons in 264,856 man-hours, with only three trifling accidents aggregating 21 days lost time. In addition to taking first place in the nation-wide bituminous mine Sentinels of Safety competition, Alabama coal mines also held second and third places, Corona No. 16 mine of the DeBardeleben Coal Corporation, Coal Valley, Ala., ranking second and Corona No.12 mine of the DeBardeleben Coal Corporation, Corona, Ala., ranking third.

Table 4 gives the tonnage and time ratings for six divisions of the Alabama mines for 1927, 1928, and 1929. These divisions have been made according to the production, as shown, in order to find what differences existed in the [illegible] hazards of large and small mines and in which divisions the greater number of fatal accidents occurred.

In Class 1, comprising all small openings--ranging from 40 to 80--producing from a few tons to 10,000 tons a year, only one or two fatalities were found. Because of the small production and time involved a difference of one fatal accident will show this to be on a par with the other divisions or much more dangerous to the individual.

Class 2, mines producing 10,000 to 50,000 tons, decreased from 70 mines producing 1,774,440 tons in 1927 to 37 mines with 847,571 tons in 1929, reversing the trend of Class 1. The hazards in mines of this class are about twice as great as hazards in mines of the larger producing groups; yet, had it not been for a major disaster charged to this group in 1929, that year would have shown an improvement in its ratings, making it rank higher than the average. Improvement in other sources of accidents is due to the greatly increased standards of safety education and inspection adopted by the operators and the State.

Class 3--producing 50,000 to 100,000 tons--is average in all respects. Its ratings are about the same as the average of all mines, and no material change has been shown in the number of mines, their tonnage, or the fatal accidents.

Class 4--mines of 100,000 to 200,000 tons production a year--has almost as many mines as Class 3, but shows a better record than mines of that group. Marked improvement was shown in 1928 and 1929 over the 1927 record. Safety in the mines of this group receives better attention than in classes 2 and 3, and the result is reflected in the favorable ratings of 3.27 fatalties per million tons produced and 1.06 per million hours worked.

Class 5, with 20 mines ranging from 200,000 to 500,000 tons production yearly, is rated about equal to class 3. The probable cause of its less favorable showing than that of classes 4 and 6 is a lack of sufficient and as efficient supervision at the working faces as in the mines of those classes. No improvement in this class has been shown for the three years.

Class 6, mines producing over 500,000 tons, had 4 representatives in 1927; 6 in 1928, and 7 in 1929. In 1927, the fatality rate per million tons mined was 3.87; in 1928; 2.97; and in 1929, 1.95. The rate per million hours worked was, in 1927, 1.61; in 1928, 1.02; and in 1929, 0.84. This marked improvement is unquestionably the result of care and effort toward the elimination of accidents. These large mines may have advantages in management and resources not found in smaller units, but they also have, at least in some cases, to contend with hazards that the others do not have. Increased efficiency is noted in class 6 in the number of tons produced per man-hour through the wider use of mechanical mining and better systems of mining. The effect of this trend in the fatality rates is naturally favorable from the lessened opportunities of injury.

Considering the averages of all classes combined 1928 shows an improvement over 1927. The small increase in 1929 over 1928 is due to a major disaster in class 2, without which a gratifying reduction would have been shown. Nevertheless, it is encouraging to note that the miner in Alabama is now safer than in the United States as a whole, although it is slightly more costly in life to produce a ton of coal.

Table 4.-

Fatality rates in Alabama coal mines - 1927, 1928, 1929

Year	Mines	Tons	Man-hours	Total Fatalities	Fatalities Per million tons	Fatalities Per million man-hours
Class 1 - Under 10,000 tons						
1927	38	115,106	675,000	2	15.74	2.95
1928	70	191,476	748,000	1	5.25	1.32
1929	84	163,207	810,000	2	12.25	2.47
Class 2 - 10,000 to 50,000 tons						
1927	70	1,774,440	5,911,000	16	9.05	2.70
1928	43	1,025,633	3,134,000	9	8.80	2.87
1929	37	847,871	2,793,000	13	15.35	4.64
Class 3 - 50,000 to 100,000 tons						
1927	33	2,518,044	7,994,000	10	3.98	1.25
1928	38	2,642,465	8,081,000	12	4.55	1.49
1929	33	2,441,950	7,345,000	10	4.09	1.36
Class 4 - 100,000 to 200,000 tons						
1927	30	4,459,082	11,390,000	20	4.48	1.76
1928	29	4,103,944	11,878,000	12	2.92	1.01
1929	27	3,674,775	11,255,000	12	3.27	1.06
Class 5 - 200,000 to 500,000 tons						
1927	26	7,957,240	22,459,000	32	4.03	1.43
1928	19	5,598,732	13,793,000	20	3.58	1.45
1929	20	6,156,877	17,618,000	25	4.06	1.42
Class 6 - over 500,000 tons						
1927	4	3,367,014	8,070,000	13	3.87	1.61
1928	6	4,371,260	12,775,000	13	2.97	1.02
1929	7	5,131,234	11,862,000	10	1.95	0.84
All mines - totals						
1927	201	20,190,926	56,499,000	93	4.60	1.65
1928	205	18,056,116	50,409,000	67	3.70	1.33
1929	208	18,416,000	51,683,000	72	3.91	1.40

FATALITY - CAUSES

The fatalities in Alabama coal mines are classified as to cause and given for each year since 1893 in Table 5 and compared with the yearly total for the United States. The sources of these figures have been the records of the State mine inspectors and the publications of the U. S. Bureau of Mines. Before 1900, only partial returns were made, so that the figures given are approximate prior to that date.

From 1900 to 1929, the division by cause of fatal accidents has been:

	1900 to 1929, per cent	1928 and 1929, per cent
Falls of rock and coal	38.0	40.0
Haulage	14.0	26.0
Electricity	6.3	17.3
Machinery	1.3	2.9
Explosives	4.1	2.9
Gas & dust explosions	31.8	8.7
Miscellaneous	4.5	2.2
Total	100.0	100.0

Falls or rock and coal claimed 61 victims of carelessness in 1927, which moved the operators and the State to start an intensive campaign for greater care in testing and timbering the roof and face.

Table 5.-

Yearly fatalities by causes

Year	Falls of roof and coal	Haulage	Electricity	Machinery	Explosives	Gas and dust	Misc.	Total	
								Ala.	U.S.
1900	19	4	-	-	3	2	9	37	1,492
1901	24	6	-	-	6	2	3	41	1,549
1902	29	9	-	2	10	-	-	50	1,895
1903	22	6	-	-	3	18	8	57	1,752
1904	38	7	-	-	3	26	10	84	2,004
1905	34	8	1	-	4	131	8	186	2,232
1906	50	12	6	6	7	13	2	96	2,138
1907	34	16	4	-	6	82	12	154	3,242
1908	39	16	10	-	12	9	22	108	2,445
1909	70	17	4	-	10	26	2	129	2,642
1910	55	20	6	1	10	139	7	238	2,821
1911	47	14	6	-	5	130	7	209	2,656
1912	61	16	7	1	5	25	6	121	2,419
1913	68	19	5	-	2	27	3	124	2,785
1914	55	24	11	1	1	34	-	126	2,454
1915	23	18	8	1	4	8	1	63	2,269
1916	28	15	9	2	3	59	2	118	2,226
1917	52	26	9	5	2	12	2	108	2,696
1918	58	23	4	2	5	10	8	110	2,580
1919	36	18	9	1	2	24	3	93	2,323
1920	34	15	4	2	6	13	4	78	2,272
1921	38	12	12	2	8	7	1	80	1,995
1922	46	14	7	1	1	112	2	183	1,984
1923	44	19	9	3	2	8	4	89	2,462
1924	39	9	16	1	5	3	4	77	2,402
1925	49	19	11	2	7	65	9	162	2,234
1926	42	31	18	4	-	42	2	139	2,518
1927	61	15	8	2	1	3	3	93	2,224
1928	28	17	13	4	4	-	1	67	2,176
1929	28	19	11	-	-	12	2	72	2,181
1900 1929	1251	464	208	43	137	1042	147	3292	69,068
1928 1929	56	36	24	4	4	12	3	139	

Results were immediate and gratifying, as shown, in that there were but 28 falls-of-roof fatalities in 1928 and 28 in 1929, with a prospect of better records to follow. Fewer men are now killed from falls of roof and coal than in the past, the average being 41 men a year, but in percentage of the yearly fatality total it ranks the same because of the reduction in fatalities from gas and dust explosions. Haulage has become more and more a source of fatal and serious injury, being now 26 per cent of the fatality total, and electricity is now responsible annually for twice as many deaths as in the 30-year average. Machinery and explosives are relatively unimportant, as are the few causes classed as miscellaneous. The excellent record in respect to explosions of gas and dust in the last three years is the result of the steps taken to prevent repetition of former disasters, by the use of rock-dusting, closed lights, improved ventilation, and adequate inspection and correction of dangerous conditions.

The causes of the fatal accidents in Alabama from 1927 to 1929 inclusive are given in Table 6, divided according to the classes of mines, as in Table 4. In the tabulations of percentages of fatalities compared to the percentages of tonnage produced, classes 4 and 6 alone have a favorable rating, class 2 being the worst and the others about average. Here again it may be stated that the one explosion in 1929 keeps class 2 from an otherwise very favorable showing, but the record as it stands points to a class of mine which is likely to be carelessly handled.

Rock falls head the list in all but class 4, where they were reduced from 15 in 1927 to 3 and 2 in 1928 and 1929 respectively. Class 2 mines also improved in this respect, from 13 fatalities in 1927 to 5 and 3 fatalities in 1928 and 1929, respectively.

In the mines of class 5 rock falls continue to kill more men than in the others, in spite of efforts to curb this danger. Probably lack of care and supervision at the working faces in this class of mines is responsible for the lack of improvement, in contrast to the results obtained in classes 4 and 6.

Haulage fatalities are on the increase, except in class 6, which speaks well for the large mines with well-regulated haulage and not so well for the rest, where chances are being taken in meeting increased haulage demands.

The bulk of electrocutions occur in classes 3, 4, and 5; class 4 heads the list with 4 out of the 11 fatalities from electrocution, or about 37 per cent of the fatalities from electricity, with but 20 per cent of the production of coal. The reason for such a poor record in this class is that the trolley wire is usually hung low and is largely unguarded.

In 1929 there were no fatalities from machinery or explosives; the record in connection with explosives is especially noteworthy, and is due largely to the widespread uses of permissible explosives in Alabama mines.

Gas and dust explosions are being reduced and guarded against in practically every feasible way in the hope that the disaster in class 2 will be the last major explosion.

Table 6.-

Causes of coal-mine fatalities in Alabama, 1927, 1928, 1929

Class	Rock falls	Haulage	Electricity	Machinery	Explosives	Gas & dust	Miscellaneous	Total	Year	Mines, No.	Tonnage percent	Fatalities, percent
Class 1	2	-	-	-	-	-	-	2	1927	38	0.6	2.1
10,000	1	-	-	-	-	-	-	1	1928	70	1.1	1.5
Tons	1	1	-	-	-	-	-	2	1929	84	0.9	2.8
Class 2	13	1	1	-	-	-	1	16	1927	70	8.7	17.2
10,000 to	5	2	2	-	-	-	-	9	1928	43	5.7	13.4
50,000 Tons	3	-	-	-	-	10	-	13	1929	37	4.6	18.1
Class 3	8	1	-	-	-	-	1	10	1927	33	12.5	10.8
50,000 to	6	2	2	2	-	-	-	12	1928	38	14.7	17.9
100,000 Tons	5	2	3	-	-	-	-	10	1929	33	13.2	13.8
Class 4	15	3	1	1	-	-	-	20	1927	30	22,2	21.5
100,000 to	3	4	4	-	-	-	1	12	1928	29	22.9	17.9
200,000 Tons	2	5	4	-	-	-	1	12	1929	27	20.0	16.7
Class 5	14	8	4	1	1	2	2	32	1927	26	39.3	34.5
200,000 to	8	6	2	1	3	-	-	20	1928	19	31.3	30.0
500,000 Tons	10	9	3	-	-	2	1	25	1929	20	33.3	34.8
Class 6	9	2	2	-	-	-	-	13	1927	4	16.7	13.9
Over	5	3	3	1	1	-	-	13	1928	6	24.3	19.3
500,000 Tons	7	2	1	-	-	-	-	10	1929	7	28.0	13.8
All mines	61	15	8	2	1	3	3	93	1927	201		
	28	17	13	4	4	-	1	67	1928	205		
	28	19	11	0	0	112	2	72	1929	208		

CONCLUSIONS

How are accidents in the mining industry being lessened and some mines operating from year to year without fatal and in some instances without even lost-time accidents?

The answer is, by systematic, honest, determined effort of operating officials from the highest down. First the management must be "sold" on the prevention of accidents and must instill the same idea into all employees. The operating officials must feel and realize that they are the responsible persons in the prevention of accidents.

Safety education, supervision and safety rules are essential in the reduction of accidents but may give only minor results unless the mine officials from the top down are actively interested in working safely.